Instruction Handbook for....

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BROAD ST.
CALIBRATION LAB

AIL TYPES 391 and 390
MICROWAVE CRYSTAL TEST SET
Part Numbers 39110 and 39013

March 1962

CUTLER-HAMMER
AIRBORNE INSTRUMENTS LABORATORY
DEER PARK, LONG ISLAND, NEW YORK
CONTROL AIL DIVISION

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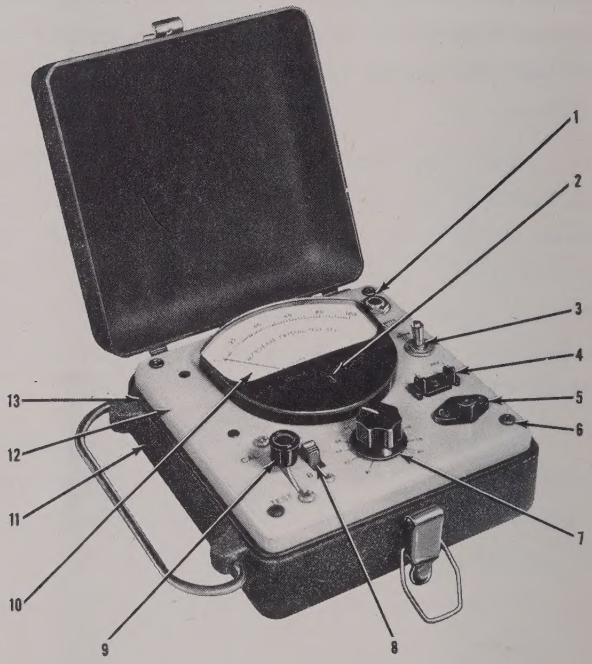
I. INTRODUCTION

Optimum performance of microwave receivers depends largely upon the characteristics and condition of the crystals in the mixer circuits and detector circuits. Testing the crystals periodically, and replacing those that have been damaged and those whose characteristics have changed through deterioration, will help to maintain microwave receivers at peak efficiency.

Microwave Crystal Test Set Type 391 and Microwave Crystal Test Set Type 390 are designed to quickly and reliably indicate the performance quality of microwave crystals; they measure the relative sensitivity of detector crystals and the relative noise figure of mixer crystals. For receivers that use balanced mixers, the test sets facilitate the selection of matched pairs of crystals.

The Type 391 and Type 390 test sets are essentially alike; they differ in that the Type 391 can test biased crystals (Type 1N263) in addition to the more frequently used crystals that the Type 390 can test.



1. REMOTE TEST JACK
2. Zero adjust
3. NORM/REV switch
4. Crystal holder
5. Crystal holder
6. Screw
7. Calibration control knob
8. A/B switch
9. CAL/TEST switch
10. Meter
11. Case assembly
12. Panel assembly
13. Gasket

FIGURE 1. MICROWAVE CRYSTAL TEST SET, TYPE 391

II. GENERAL INFORMATION AND SPECIFICATIONS

A. SCOPE OF HANDBOOK

The instructions in this handbook apply to both types of microwave crystal test sets: Type 391 (Part No. 39110), and Type 390 (Part No. 39013). The two types are alike in most respects; where Type 390 differs from Type 391, the difference is described in Section VII.

B. SPECIFICATIONS

Microwave Crystal Test Set Type 391 (Figure 1) is battery-powered, self-contained, and portable; it is 6-1/2 inches long, 6-1/4 inches wide, and 3-1/4 inches high, and it weighs about 3 pounds. Table I summarizes the principal specifications of the Test Set.

TABLE I. SPECIFICATIONS

Relative-noise-figure error	Max: 1.0 db Mean: 0.3 db
Relative-sensitivity error	Max: 2.0 db Mean: 0.6 db
Pair-matching sensitivity	Sufficient to assure 20-db suppression of local-oscillator noise
Conversion-loss error	Max: 0.9 db Mean: 0.3 db
Noise-temperature error	Max: 0.7 db Mean: 0.3 db
Adaptability	Tests ceramic, coaxial-lead, and axial-lead crystal diodes of both normal and reversed polarity.

III. OPERATING INSTRUCTIONS

A. OPERATING CONTROLS

The controls and other operating features of the Test Set are listed in Table II.

TABLE II. TEST SET CONTROLS

Index No., Figure 1	Name	Purpose
1	REMOTE TEST JACK	To test a crystal diode without removing it from the equipment in which it is used.
2	Zero adjust	To mechanically set the meter pointer to zero.
3	NORM/REV switch	To provide correct bias-voltage polarity for the crystal diode being tested; and to determine the polarity of a crystal diode when it is not known or when the crystal diode is located remotely from the Test Set.
4	Crystal holder	To connect a cartridge-type crystal diode to the circuit of the Test Set.
5	Crystal holder	To connect an axial-leads-type crystal diode to the circuit of the Test Set.
7	Calibration control	To set the initial bias voltage across the crystal diode being tested.

TABLE II. TEST SET CONTROLS (cont)

Index No., Figure 1	Name	Purpose
8	A/B switch	To permit testing crystal diodes that require reduced bias voltage.
9	CAL/TEST switch	To switch the circuit to calibrate the test set (CAL) and then to test a crystal diode (TEST); to automatically shut off battery power when Test Set is not in use.
10	Meter	To provide a scale-indication of quality of crystal diode being tested.

B. PREPARING TEST SET FOR USE

Install a D-size battery in the Test Set as follows:

1. Remove the four corner screws (6, Figure 1) and lift the panel assembly (12) out of the case assembly (11).
2. Install the battery in the holder on the underside of the panel assembly (Figure 2) so that the positive terminal (center post) of the battery touches the holder terminal that is marked with a red +.
3. Reinstall the panel assembly in the Test Set case, and secure it with the four screws.

C. PROTECTING CRYSTALS FROM BURNOUT OR DAMAGE FROM BODY STATIC ELECTRICITY

Always ground a crystal diode and discharge body static electricity before inserting the diode into the Test Set and before installing the diode into communications equipment; a

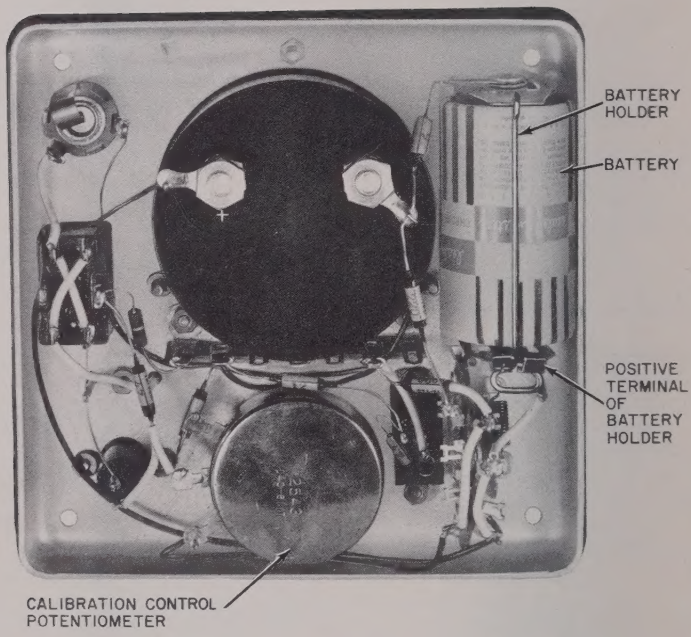


FIGURE 2. PANEL ASSEMBLY, BOTTOM VIEW

crystal can be damaged if body static electricity is discharged through it. To protect the crystal, proceed as follows:

1. Hold the crystal diode by its metal shell between the thumb and fingers of one hand.
2. Touch the hand holding the crystal to the latch on the Test Set case.
3. Insert the crystal diode into the diode holder in the Test Set.

Before installing a crystal diode into communications equipment, touch the hand holding the crystal to the equipment chassis.

D. TESTING CRYSTAL DIODES FOR USE IN UNBALANCED-MIXER CIRCUITS

1. Zero the pointer of the meter (10), if necessary, by turning the zero-adjust screw (2).
2. Turn the calibration control (7, Figure 1) to the 76 mark, approximately.
3. Set the A/B switch (8) to A.

NOTE

If crystal diode being tested is Type 1N263, set A/B switch to B.

4. Ground the crystal diode, as described in paragraph III-C, and insert it gently into the crystal-diode holder (4 or 5).
5. Throw the NORM/REV switch (3) to the appropriate position: NORM if the diode's polarity is conventional, REV if its polarity is reversed.

NOTE

If the diode's polarity is not known, choose the NORM/REV switch position that gives the higher meter indication when the CAL/TEST switch (9) is held at CAL.

6. Hold the CAL/TEST switch (9) at CAL, and adjust the calibration control (7) until its marker and the pointer of the meter (10) indicate the same numerical values.

7. Throw the CAL/TEST switch to TEST, and hold the switch in this position until the pointer of the meter comes to rest.

8. Observe the indicated values on the 0-to-100 scale of the meter, then release the CAL/TEST switch.

9. The lower the meter indication, the better the performance quality of the crystal. See Table III for the maximum acceptable indication (Maximum Accept-Value column) for the type of crystal diode being tested.

10. To determine the noise figure of the tested crystal diode, see Figure 3; to estimate the relative receiver noise figure, see Figure 4.

11. Remove the tested crystal diode from the Test Set and store it, or dispose of it, or--after grounding it as described in paragraph III-C--install it in the equipment in which it is to be used.

E. TESTING CRYSTAL DIODES FOR USE IN BALANCED-MIXER CIRCUITS

1. Follow the same procedure as for testing crystal diodes for use in unbalanced-mixer circuits (paragraph III-D), but record the CAL values of each crystal in step 5 and the TEST values in step 6; then pair the crystal diodes that have values equal within 1/2 scale division on the meter scale.

2. If none of the tested crystal diodes match within 1/2 scale division, pair those diodes whose CAL and TEST values differ in the same direction. For example, pair a CAL 63/TEST 24 diode with a CAL 65/TEST 25 diode rather than with a CAL 65/TEST 23 diode.

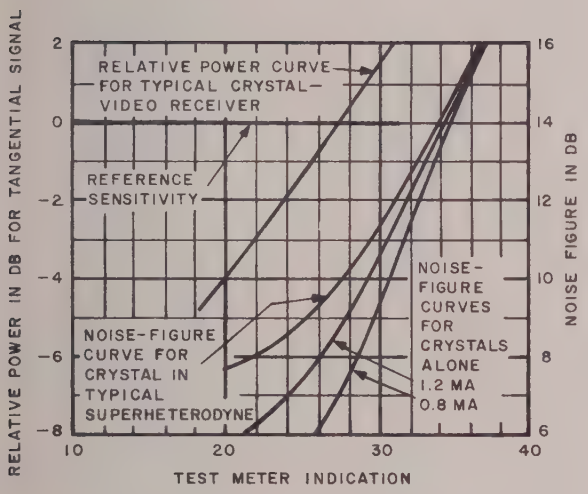


FIGURE 3. CALIBRATION CURVES

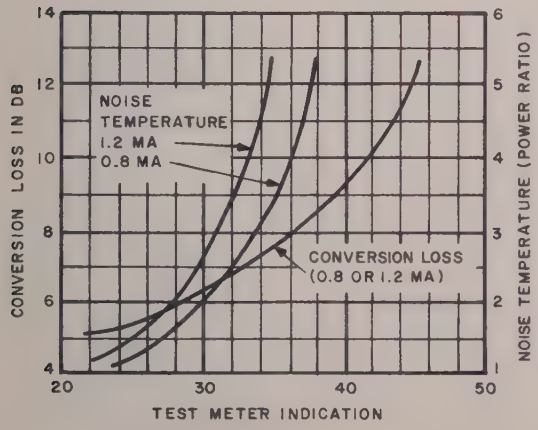


FIGURE 4. CONVERSION-LOSS AND NOISE-TEMPERATURE CURVES

TABLE III. MAXIMUM ACCEPT-VALUES OF MICROWAVE CRYSTAL DIODES

Type	Maximum Accept-Value	Type	Maximum Accept-Value
1N21	35.0	1N29	27.5
1N21A	32.5	1N31*	27.5
1N21B	30.0	1N32*	27.5
1N21BM(R)	30.0	1N53/D938**	28.0
1N21C	27.5	1N53M(R)	28.0
1N21CM(R)	27.5	1N78	27.0
1N21D	25.0	1N78A	27.0
1N21DM(R)	25.0	1N78AR	27.0
1N21E	25.0	1N78M(R)	27.0
1N21EM(R)	25.0	1N78AM(R)	27.0
1N23	35.0	1N156	30.0
1N23A	32.5	1N157	30.0
1N23B	30.0	1N197	30.0
1N23BM(R)	30.0	1N259	30.0
1N23C	27.5	1N263†	34.0
1N23CM(R)	27.5	1N264	30.0
1N23D	25.0	1N415B(M)	30.0
1N23DM(R)	25.0	1N415C(M)	27.5
1N23E	25.0	1N415D(M)	25.0
1N23EM(R)	25.0	1N415E(M)	25.0
1N23WE(M)	25.0	1N416B(M)	30.0
1N25	35.0	1N416C(M)	27.5
WE1N26	30.0	1N416D(M)	25.0
SYL1N26	32.5	1N416E(M)	30.0
1N28	30.0		

* See paragraph III-F for special procedure.

** Requires adapter to connect center pin and shell of diode to center contact and outer contact of diode holder.

†Set A/B switch to B.

F. TESTING TYPE 1N31 AND TYPE 1N32 DETECTOR CRYSTAL DIODES

Follow the same procedure as for testing crystal diodes for use in unbalanced-mixer circuits (paragraph III-C) with this exception: in step 5 of paragraph III-C hold the CAL/TEST switch at CAL, and adjust the calibration control until the meter pointer indicates 56, for testing a Type 1N31 crystal, or 65, for testing a Type 1N32 crystal. Then proceed as in steps 6 through 10 of paragraph III-C.

G. ADDITIONAL TEST FOR CRYSTAL DIODES OF DOUBTFUL QUALITY

To further test a crystal diode that has been damaged and whose TEST indication is just a little higher than the listed Maximum Accept-Value in Table III, modify its TEST indication by a factor obtained by measuring the relative back-current of the diode. Proceed as follows:

1. After observing the TEST indication on the meter scale, as in step 7 of paragraph III-D, hold the CAL/TEST switch at TEST, and throw the NORM/REV switch to the position that is opposite to the one in which the TEST indication was made. Record the meter indication, return the NORM/REV switch to its preceding position, and release the CAL/TEST switch.
2. From Figure 5, determine the correction increment that corresponds to the back-current meter indication recorded in step 1.
3. Add the correction increment to the noise figure of the diode (as determined from Figure 3) and to the noise temperature and conversion loss of the diode (as determined from Figure 4).

The modifying correction increment will depend upon what the original TEST indication was; if the TEST indication

was 30 or less, the correction increment will be as indicated in Figure 5; if it was between 30 and 35, divide the correction increment indicated in Figure 5 by 2; if it was 35 or higher, no correction increment should be added.

The correction to be added to noise temperature--and therefore to noise figure--depends upon the rectified crystal current. Two curves for each are shown in Figure 5: one for 0.8 ma, and one for 1.2 ma. These curves correspond approximately to 0.5 mw and 1.0 mw, respectively, of absorbed power. The standard MIL test conditions at S-band and X-band call for 0.5 mw and 1.0 mw, respectively, of absorbed power.

The accuracy with which the Test Set can predict the results that would be obtained in the standard RF test set, therefore, is determined in part by the degree of match between the crystal and the holder; mismatch reduces the excitation level of the crystal. In the usual receiver application, where rectified crystal current is adjusted to a particular optimum value (usually between 0.3 and 0.8 ma), the agreement between Test Set readings and crystal quality should be better than in applications where available power is held constant.

H. REMOTE TESTING OF CRYSTAL DIODES

The REMOTE TEST JACK (1, Figure 1) provides a means of testing a crystal diode without removing the diode from the equipment in which it is used. The REMOTE TEST JACK will accept a plug (JAN PL-55) that can be connected by cable to convenient points in the equipment circuit that lead to the crystal diode. Shut off the power to the equipment in which the diode under test is located.

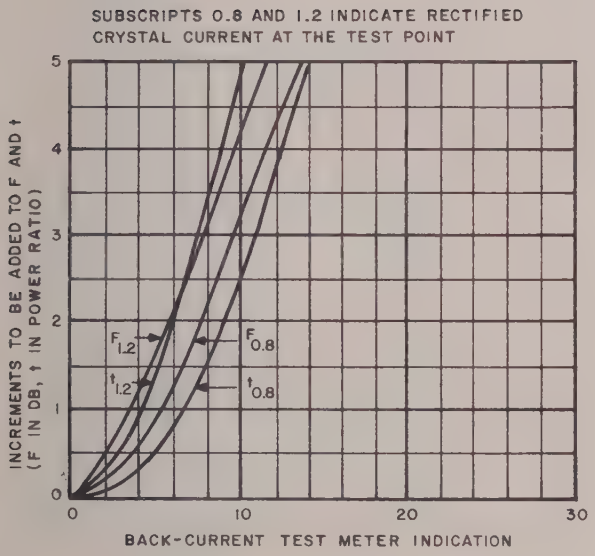


FIGURE 5. CORRECTIONS FOR RELATIVE BACK CONDUCTANCE

I. STORING TEST SET

Remove the battery from the Test Set if it is to be stored, shipped, or not used for a period of one week or longer.

IV. THEORY OF OPERATION

A. BASIC PRINCIPLE

Operation of the Test Set is based on the theory that the performance quality of a crystal diode depends largely upon the extent to which its static voltage-current (E-I) curve is non-linear. Figure 6 shows an example of an E-I curve for a typical crystal diode.

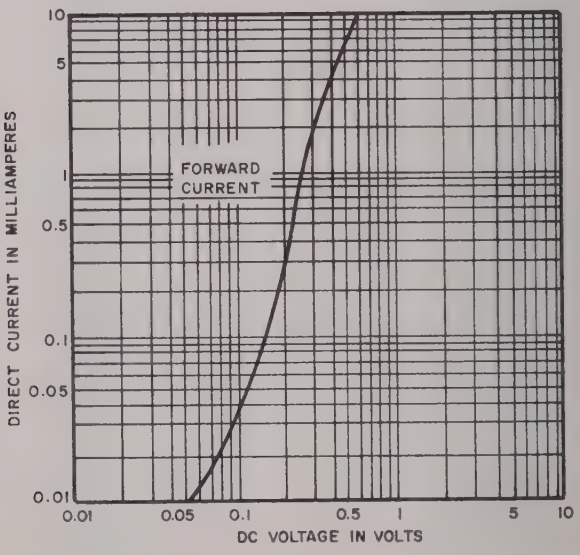


FIGURE 6. STATIC VOLTAGE-CURRENT (E-I) CURVE OF TYPICAL CRYSTAL DIODE

The Test Set indicates the extent to which the E-I curve of a crystal diode is nonlinear; it measures the current passed by the diode when its forward-bias voltage has been reduced a fixed amount from an initially applied (CAL) bias voltage, and it indicates the current as a numerical value on a 0-to-100 meter scale.

B. DETAILED CIRCUIT DESCRIPTION

When CAL/TEST switch S101 (Figure 7) is in its center position and switch S103 is at A, a resistance (composed of calibration control potentiometer R101 and resistors R102, R104, R105, R106, R107, and R109) is applied across the terminals of meter M101 and provides electrical protection for the meter in transit and during storage.

With CAL/TEST switch S101 at CAL, NORM/REV switch S102 at NORM, and A/B slide switch S103 at A, the forward-bias voltage applied to a crystal diode in holder X101 or X102 is determined by the setting of R101 and by resistors R102, R104, R105, R106, R107, and R109. When R101 is adjusted so that its control-knob marker indicates the same numerical value as the pointer of meter M101, the initial (CAL) bias voltage is established across the diode being tested in holder X101 or X102.

When CAL/TEST switch S101 is thrown from CAL to TEST, resistor R103 is brought into the circuit. This causes an increase in voltage at the negative terminal of meter M101 and, thus, a corresponding increase in voltage at the negative contact of holder X101 or of holder X102 and results in a decrease in bias voltage across the crystal diode that is being tested in the holder. If the quality of the crystal diode is good--that is, if its E-I curve is sufficiently nonlinear--the current through

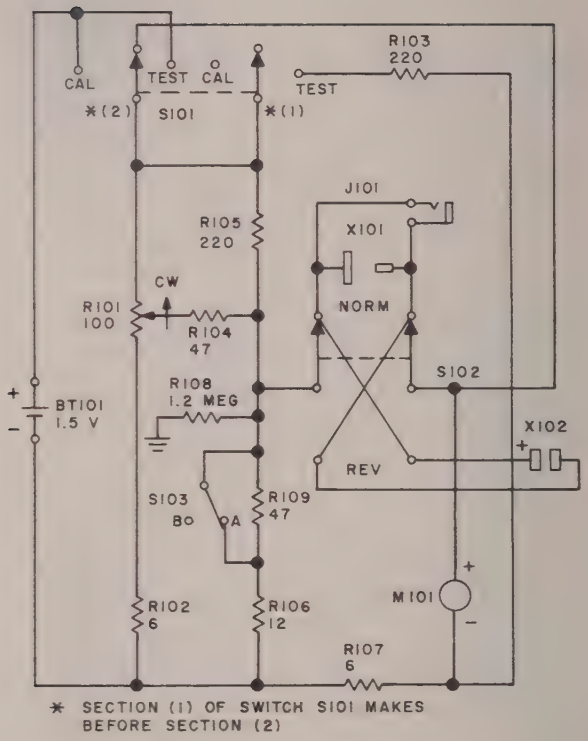


FIGURE 7. ELECTRICAL SCHEMATIC DIAGRAM, MICROWAVE CRYSTAL TEST SET, TYPE 391

M101 will decrease sufficiently to move the pointer of M101 to a lower numerical scale value. If the quality of the crystal has deteriorated--that is, if its E-I curve has become too nearly linear--the current through M101 will not decrease sufficiently to deflect the meter pointer to a scale value low enough to indicate that the crystal is acceptable.

REMOTE TEST JACK J101 is connected in parallel with crystal holders X101 and X102 and is intended for testing crystal diodes without removing them from the equipment in which they are used. Slide switch S103 bypasses resistor R109 when it is closed (position A) and is intended for decreasing the voltage across the crystal holders X101 and X102 when testing a Type 1N263 crystal diode.

V. MAINTENANCE

Maintenance of the Test Set consists of preventive maintenance, periodic testing, troubleshooting, repair, and parts replacement.

A. PREVENTIVE MAINTENANCE

Whenever the panel assembly is disassembled from the case--as when the battery is replaced--inspect and clean the Test Set as follows:

1. Blow out any dirt and dust with a moderate jet of dry air.
2. Clean off any visible corrosion with a blade, brush, or crocus cloth.
3. Examine and, if necessary, replace any components that appear to be damaged.
4. Test the Test Set as described in paragraph B below.

B. PERIODIC TESTING

When the Test Set has been stored and not used for a period of one month or more, or when a part has been replaced or repaired, test the Test Set as follows:

1. Test the voltage of the battery that is to be used in the Test Set; it should be 1-1/2 volts under rated load. Install the battery in the Test Set.
2. Throw the CAL/TEST switch to CAL and then to TEST while the NORM/REV switch is at NORM and again when the NORM/REV switch is at REV; the pointer of meter M101 should remain at zero. If necessary, zero the pointer by turning the zero-adjust screw.

3. Turn the calibration control fully clockwise, connect a 680-ohm resistor across the two terminals of holder X101, throw the NORM/REV switch to NORM, throw the CAL/TEST switch to CAL, and adjust the calibration control until it indicates the same numerical value as the pointer of the meter; the meter should then indicate between 68 and 72.

4. Throw the CAL/TEST switch to TEST; the meter should indicate between 40 and 45.

5. Release the CAL/TEST switch, replace the 680-ohm resistor with a 1500-ohm resistor, and throw the CAL/TEST switch to TEST; the meter should indicate between 19 and 21.

C. TROUBLESHOOTING

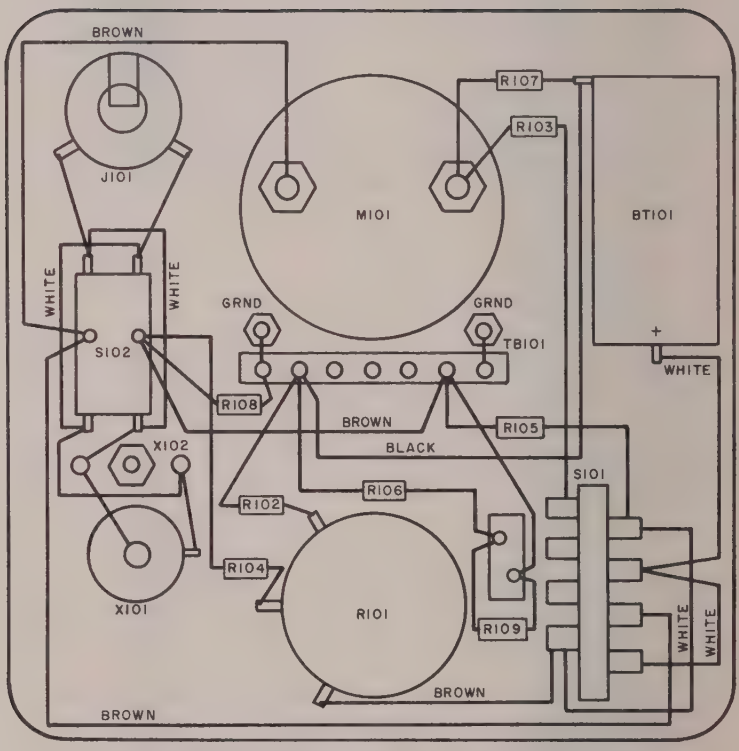
Some indications of trouble that may be encountered in using the Test Set are listed in Table IV along with possible causes and remedies. The cause and remedy of trouble not listed can usually be found by visual inspection or point-to-point circuit testing with a multimeter (Figure 8).

CAUTION

Short circuit the terminals of the meter and remove battery from Test Set when measuring resistances in the circuit.

D. REPAIR

Repair of the Test Set will usually be a simple matter of cleaning or parts replacement.



WIRE SIZE NO. 22 STRANDED (WHERE WIRE COLOR IS NOT SHOWN, THE COMPONENT LEAD WAS USED AS THE CONDUCTOR)

FIGURE 8. WIRING DIAGRAM, MICROWAVE CRYSTAL TEST SET, TYPE 391

TABLE IV. TROUBLESHOOTING

Trouble Indication	Possible Cause and Remedy
Meter M101 pointer creeps down-scale when CAL/TEST switch is at CAL and a crystal diode is being tested.	Battery voltage is low. Install a new, size-D, 1-1/2 volt dry-cell battery.
Meter M101 pointer is off zero position when CAL/TEST switch is at center position.	Excessive voltage might have been applied to the meter. Adjust the zero-adjust screw to return the pointer to zero on scale.
Meter M101 pointer flickers back and forth when CAL/TEST switch is at CAL and a crystal diode is being tested.	Crystal holder X101 or X102 contacts are bent, broken, or dirty. Clean or repair contacts, or replace the holder.
Meter M101 pointer flickers back and forth when connection is made to test a crystal diode through REMOTE TEST JACK J101.	Contacts on REMOTE TEST JACK J101 are worn, broken, or dirty. Clean contacts, or replace REMOTE TEST JACK J101.
Meter M101 does not indicate within tolerance required in Periodic Testing, paragraph V-B.	If all other components check out satisfactorily, test the meter for full-scale and half-scale deflection; a 200 $\pm$ 4 μa current should cause full-scale deflection of meter pointer, and a 100 $\pm$ 4 μa current should cause half-scale deflection. Replace meter M101, if necessary.

VI. REPLACEABLE PARTS

All of the items in the List of Replaceable Parts are available through Airborne Instruments Laboratory, a Division of Cutler-Hammer, Inc., Comac Road, Deer Park, New York. The reference designations (Ref Desig column) correspond to those in Figures 7 and 8.

LIST OF REPLACEABLE PARTS

Ref Desig	Part Name and Description	AIL Part No.	Figure No.	Index No.
BT101	Battery, dry-cell, 1-1/2 volt, D-size	117267-3	2	
J101	JACK, REMOTE TEST	117360-2	1	1
M101	Meter, microampere	114992	1	10
R101	Potentiometer, calibration control, 100 ohms	112543	2	
R102	Resistor, fixed, wirewound, 6 ohm ±1%, 1/4 watt	112545-1		
R103	Resistor, fixed, wirewound, 220 ohm ±1%, 1/4 watt	112545-2		
R104	Resistor, fixed, wirewound, 47 ohm ±1%, 1/4 watt	112545-3		
R105	Resistor, fixed, wirewound, 220 ohm ±1%, 1/4 watt	112545-2		

Ref Desig	Part Name and Description	AIL Part No.	Figure No.	Index No.
R106	Resistor, fixed, wire-wound, 12 ohm ±1%, 1/4 watt	112545-4		
R107	Resistor, fixed, wire-wound, 6 ohm ±1%, 1/4 watt	112545-1		
R108	Resistor, fixed, composition, 1.2 megohm ±10%, 1/2 watt	RC20GF125K		
R109	Resistor, fixed, wire-wound, 47 ohm ±1%, 1/4 watt	112545-3		
S101	Switch, CAL/TEST	112553	1	9
S102	Switch, NORM/REV	116656	1	3
S103	A/B switch	117358-2	1	8
X101	Holder, crystal (coaxial style)	118272-2	1	5
X102	Holder, crystal (axial style)	114950	1	4
	Case assembly	114996	1	11
	Gasket	112562	1	13
	Holder, battery	114992	2	
	Knob, calibration control	118883-2	1	7

VII. DIFFERENCE DATA FOR TYPE 390 MICROWAVE CRYSTAL TEST SET

The Type 390 Microwave Crystal Test Set (Figure 9) is the same as the Type 391 Test Set except as described in the following paragraphs.

A. METER

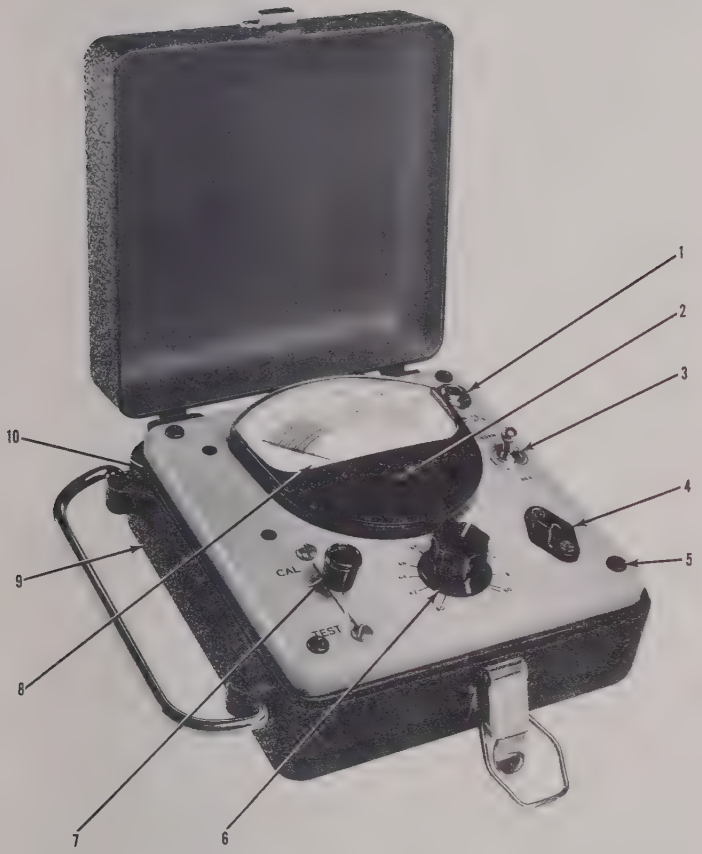
The face of the meter (8, Figure 9) has--in addition to a 0-to-100 scale--four sector-shaped areas with crystal-diode-type numbers within them. The green bars indicate in what portion of a sector the meter pointer will come to rest if the crystal diode listed in that sector is GOOD. The black diode-type numbers are those of mixer-circuit crystal diodes; the red diode-type numbers are those of detector-circuit crystal diodes. The red marks and the red diode-type numbers on the 0-to-100 scale are intended for calibrating the Test Set when testing detector-circuit crystal diodes.

B. CRYSTAL HOLDER

The Type 390 Test Set has only one crystal holder (4, Figure 9); it will accommodate cartridge-type crystal diodes only.

C. CIRCUIT DESCRIPTION

When CAL/TEST switch S101 (Figure 10) is in its center position, a resistance (composed of potentiometer R101 and resistors R102, R104, R105, R106, and R107) is applied across the terminals of meter M101, providing electrical protection for the meter in transit and during storage.



1. REMOTE TEST JACK
2. Zero-adjust screw
3. NORM/REV switch
4. Crystal holder
5. Screw
6. Calibration control knob
7. CAL/TEST switch
8. Meter
9. Case assembly
10. Gasket

FIGURE 9. MICROWAVE CRYSTAL TEST SET, TYPE 390

When CAL/TEST switch S101 is thrown to CAL (and NORM/REV switch S102 is at NORM), the forward-bias voltage applied to the shell-contact of a crystal diode in holder X101 is determined by the setting of calibration control R101 and by resistors R102, R104, R105, R106, and R107. When R101 is adjusted so that its control-knob marker indicates the same numerical value as the pointer of meter M101, the initial CAL bias voltage is established across the diode in holder X101.

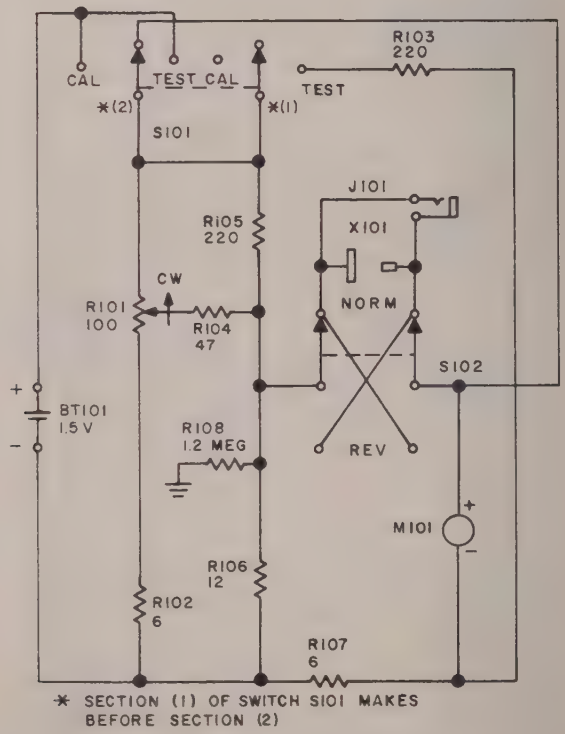


FIGURE 10. ELECTRICAL SCHEMATIC DIAGRAM, MICROWAVE CRYSTAL TEST SET, TYPE 390

When CAL/TEST switch S101 is thrown from CAL to TEST (and the setting of R101 has not changed), resistor R103 is brought into the circuit, causing an increase in voltage at the negative terminal of meter M101 and, therefore, a corresponding increase in voltage at the pin contact of the crystal diode in holder X101, resulting in a decrease in the bias voltage across the crystal diode. If the performance quality of the crystal diode is good--that is, its E-I curve is nonlinear--the current through meter M101 will decrease sufficiently to move the pointer to the green GOOD sector on the scale; if the quality of the crystal diode has deteriorated--that is, its E-I curve has become too nearly nonlinear--the current through meter M101 will not decrease sufficiently to deflect the pointer out of the white POOR sector.

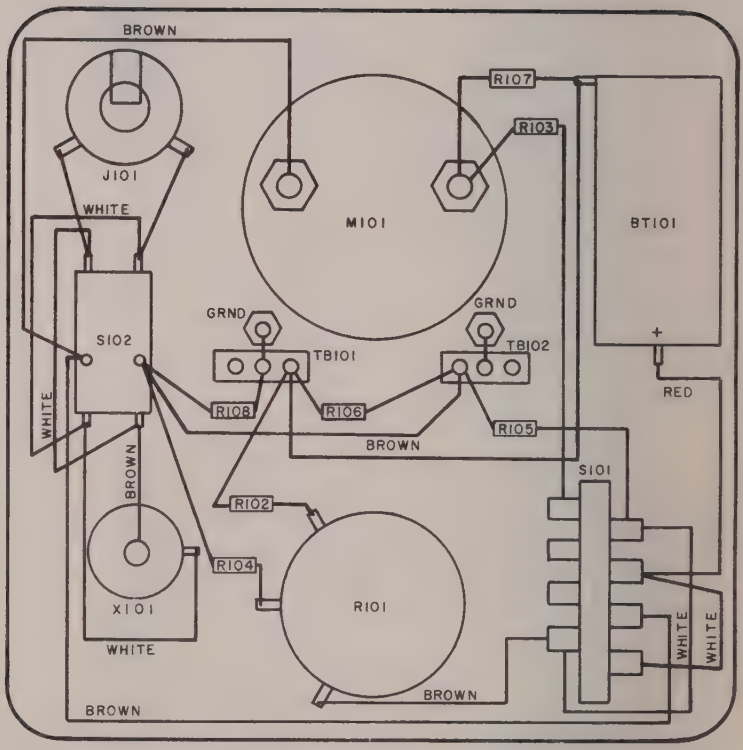
D. OPERATING INSTRUCTIONS

The Operating Instructions are the same as those for the Type 391 Test Set, but the Type 390 Test Set cannot test a Type 1N263 crystal diode, and it requires the use of an adapter to test nine axial-type diodes (Table V) that can be tested on the Type 391 Test Set without an adapter.

In testing Type 1N32 detector-circuit crystal diodes, establish the initial CAL voltage as follows: hold the CAL/TEST switch at CAL, and adjust the calibration control (6, Figure 9) until the pointer of the meter points to the red line on the scale just below the red diode-type number of the diode being tested.

E. REPLACEABLE PARTS

The reference designations in the Ref Desig column of the List of Replaceable Parts, correspond to the reference designations of parts in Figures 10 and 11.



WIRE SIZE NO. 22 STRANDED (WHERE WIRE COLOR IS NOT SHOWN, THE COMPONENT LEAD WAS USED AS THE CONDUCTOR)

FIGURE 11. WIRING DIAGRAM, MICROWAVE CRYSTAL TEST SET, TYPE 390

TABLE V. MAXIMUM ACCEPT-VALUES OF MICROWAVE CRYSTAL DIODES

Type	Maximum Accept-Value	Type	Maximum Accept-Value
1N21	35.0	1N28	30.0
1N21A	32.5	1N29	27.5
1N21B	30.0	1N31**	27.5
1N21BM(R)	30.0	1N32**	27.5
1N21C	27.5	1N53/D938*	28.0
1N21CM(R)	27.5	1N53M(R)	28.0
1N21D	25.0	1N78	27.0
1N21DM(R)	25.0	1N78A	27.0
1N21E	25.0	1N78AM(R)	27.0
1N21EM(R)	25.0	1N78AR	27.0
1N23	35.0	1N78M(R)	27.0
1N23A	32.5	1N156	30.0
1N23B	30.0	1N157	30.0
1N23BM(R)	30.0	1N197	30.0
1N23C	27.5	1N259	30.0
1N23CM(R)	27.5	1N264	30.0
1N23D	25.0	1N415B(M)*	30.0
1N23DM(R)	25.0	1N415C(M)*	27.5
1N23E	25.0	1N415D(M)*	25.0
1N23EM(R)	25.0	1N415E(M)*	25.0
1N23WE(M)	25.0	1N416B(M)*	30.0
1N25	35.0	1N416C(M)*	27.5
WE1N26	30.0	1N416D(M)*	25.0
SYL1N26	32.5	1N416E(M)*	30.0

* Requires adapter to connect center pin and shell of diode to center contact and outer contact of diode holder.

** See paragraph VII-D for special procedure.

LIST OF REPLACEABLE PARTS

Ref Desig	Part Name and Description	AIL Part No.	Figure No.	Index No.
BT101	Battery, dry-cell 1-1/2 volt, D-size	117267-3	11	
J101	JACK, REMOTE TEST	117360-2	9	1
M101	Meter, microampere	112558	9	8
R101	Potentiometer, calibration control, 100 ohm	112543	11	
R102	Resistor, fixed, wirewound, 6 ohm ±1%, 1/4 watt	112545-1		
R103	Resistor, fixed, wirewound, 220 ohm ±1%, 1/4 watt	112545-2		
R104	Resistor, fixed, wirewound, 47 ohm ±1%, 1/4 watt	112545-3		
R105	Resistor, fixed, wirewound, 220 ohm ±1%, 1/4 watt	112545-2		
R106	Resistor, fixed, wirewound, 12 ohm ±1%, 1/4 watt	112545-4		
R107	Resistor, fixed, wirewound, 6 ohm ±1%, 1/4 watt	112545-1		
R108	Resistor, fixed, composition, 1.2 megohm ±10%, 1/2 watt	RC20GF125K		
S101	Switch, CAL/TEST	112553	9	7
S102	Switch, NORM/REV	116656	9	3
X101	Holder, crystal	118272-1	9	4
	Case assembly	112535	9	9
	Gasket	112562	9	10
	Holder, battery	114992		